Over-Voltage Protection Load Switch

FEATURES

- Integrated low R_{dson} nFET switch: typical 30mΩ
- 4.5A continuous current capability
- Over-Voltage Protection (OVP) threshold
  - AW33201: 6.2V
  - AW33205: 6.8V
  - AW33209: 10.5V
- Input maximum voltage rating: $32V_{DC}$
- Fast turn-off response: typical 100ns
- Over-Temperature Protection (OTP)
- Under-Voltage Lockout (UVLO)
- 1.245mm × 1.245mm WLCSP-9 package

APPLICATIONS

- Smartphones
- Tablets
- Charging Ports

GENERAL DESCRIPTION

The AW332XX features an ultra-low 30mΩ (typ.) R_{dson} nFET load switch. When input voltage exceeds the OVP threshold, the switch is turned off very fast to prevent damage to the protected downstream devices. The IN pin is capable of withstanding fault voltages up to $32V_{DC}$.

The OVP threshold is 6.2V(AW33201), 6.8V(AW33205), 10.5V(AW33209).

This device features over-temperature protection that prevents itself from thermal damaging.

The AW332XX is available in a RoHS compliant 9-bump 1.245mm × 1.245mm WLCSP.

TYPICAL APPLICATION CIRCUIT

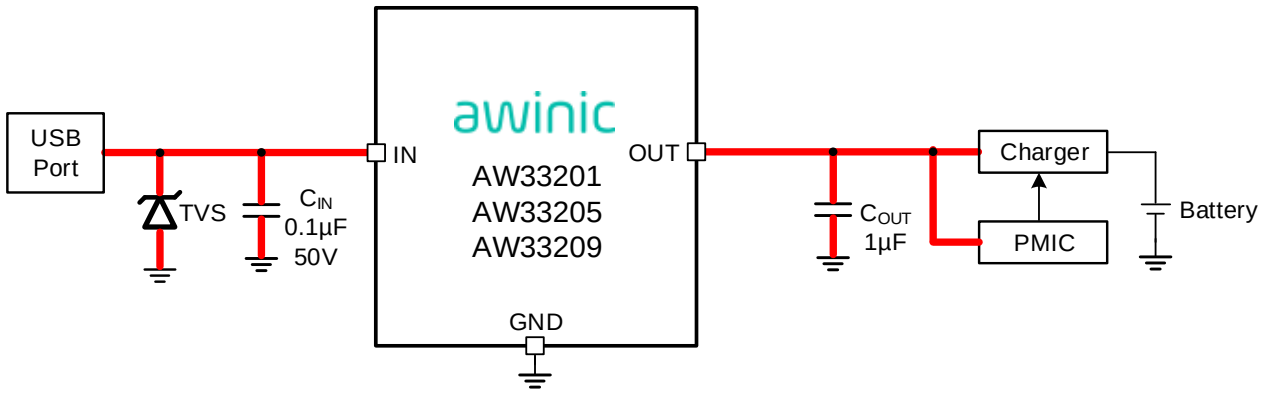

Figure 1 AW332XX typical application circuit

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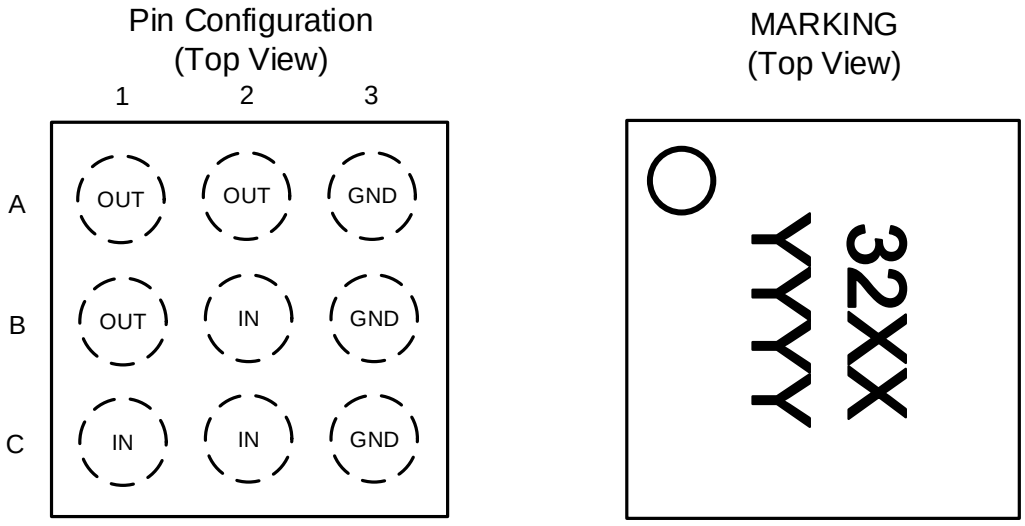
DEVICE COMPARISON TABLE

Device	V_{IN_OVLO}(V)				V_{IN_OVLO} Hysteresis(mV)
	Condition	Min.	Typ.	Max.	
AW33201	V_{IN} rising	6.0	6.2	6.4	110
AW33205	V_{IN} rising	6.66	6.80	6.94	150
AW33209	V_{IN} rising	10.2	10.5	10.8	220

PIN CONFIGURATION AND TOP MARK



32XX – AW33201/AW33205/AW33209
YYYY – Production tracking code

Figure 2 Pin Configuration and Top Mark

PIN DEFINITION

Pin	Name	Description
B2,C1,C2	IN	Switch input and device power supply
A3,B3,C3	GND	Device ground
A1,A2,B1	OUT	Switch output

FUNCTIONAL BLOCK DIAGRAM

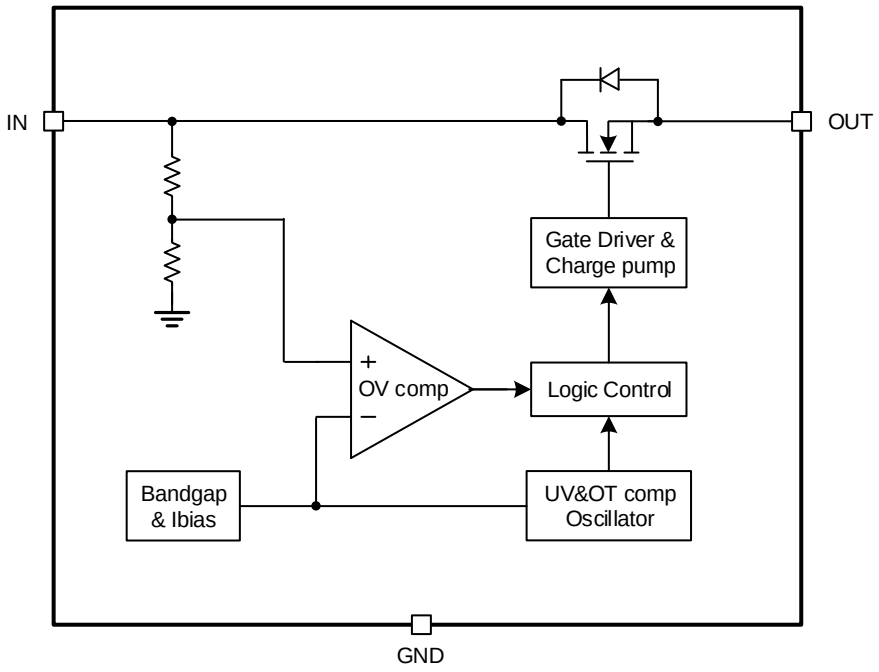


Figure 3 Functional Block Diagram

TYPICAL APPLICATION CIRCUITS

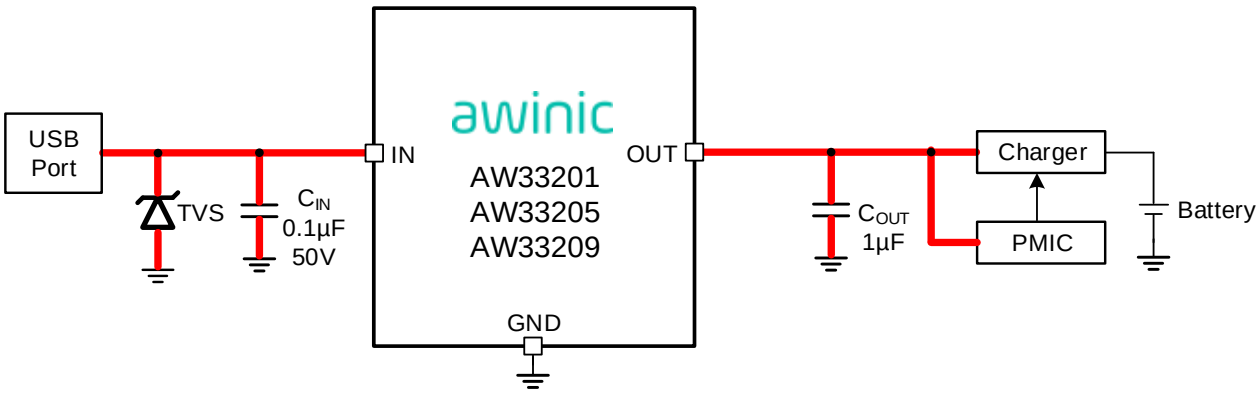


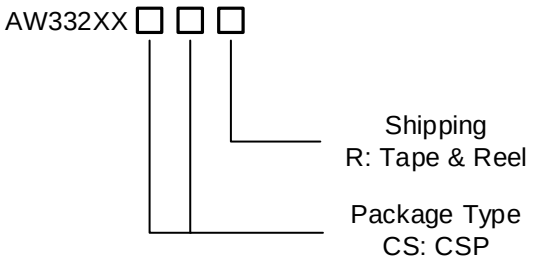
Figure 4 AW332XX typical application circuit

Notice for Typical Application Circuits:

1. C_{IN} = 0.1μF is recommended for typical application, larger C_{IN} is also acceptable. The rated voltage of C_{IN} should be larger than the TVS maximum clamping voltage, if no TVS is applied and only AW332XX is used, the rated voltage of C_{IN} should be 50V.
2. C_{OUT} = 1μF is recommended for typical application, larger C_{OUT} is also acceptable. The rated voltage of C_{OUT} should be larger than the OVP threshold. For example, if the OVP threshold is 6.8V, the rated voltage of C_{OUT} should be 10V or higher.

ORDERING INFORMATION

Part Number	Temperature	Package	Marking	Moisture Sensitivity Level	Environmental Information	Delivery Form
AW33201CSR	-40°C – 85°C	1.245mm × 1.245mm × 0.597mm WLCSP-9	3201	MSL1	ROHS+HF	Tape and Reel 3000pcs/Reel
AW33205CSR	-40°C – 85°C	1.245mm × 1.245mm × 0.597mm WLCSP-9	3205	MSL1	ROHS+HF	Tape and Reel 3000pcs/Reel
AW33209CSR	-40°C – 85°C	1.245mm × 1.245mm × 0.597mm WLCSP-9	3209	MSL1	ROHS+HF	Tape and Reel 3000pcs/Reel



ABSOLUTE MAXIMUM RATINGS (NOTE 1)

Symbol	Parameter	Condition	Min.	Max.	Unit
V_{IN}	Input DC voltage		-0.3	32	V
V_{IN_PUL}	Input peak pulse voltage	20μs pulse width, repeat 100 times		45	V
V_{OUT}	Output voltage		-0.3	See(NOTE 2)	V
I_{IN}	Switch current(NOTE 3)	Continuous current		4.5	A
T_A	Ambient temperature		-40	85	°C
T_J	Junction temperature		-40	150	°C
T_{STG}	Storage temperature		-55	150	°C
T_{LEAD}	Soldering temperature	At leads, 10 seconds		260	°C

NOTE1: Conditions out of those ranges listed in "absolute maximum ratings" may cause permanent damages to the device. In spite of the limits above, functional operation conditions of the device should within the ranges listed in "recommended operating conditions". Exposure to absolute-maximum-rated conditions for prolonged periods may affect device reliability.

NOTE2: 29V or VIN+0.3V, whichever is smaller.

NOTE3: Limited by thermal design.

THERMAL INFORMATION

Symbol	Parameter	Condition	Value	Unit
$R_{\theta JA}$	Thermal resistance from junction to ambient (NOTE 1)	In free air	85	°C/W

NOTE1: Thermal resistance from junction to ambient is highly dependent on PCB layout.

ESD AND LATCP-UP RATINGS

Symbol	Parameter	Condition	Value	Unit
V_{ESD}	Human Body Model	All pins, per MIL-STD-883J Method 3015.9	±3	kV
	Charged Device Model	All pins, per JEDEC EIA/JESD22-C101F	±2	kV
	Machine Model	All pins, per JEDEC EIA/JESD22-A115	±200	V
$I_{Latch-up}$	Latch-up	All pins, per JEDEC STANDARD NO.78E SEPTEMBER 2016, I Trigger	±800	mA

RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{IN}	Input DC voltage	2.5		30	V
C_{IN}	Input capacitance		0.1		μF
C_{OUT}	Output load capacitance		1	100	μF

ELECTRICAL CHARACTERISTICS

T_A = -40°C to 85°C unless otherwise noted. Typical values are guaranteed for V_{IN} = 5V, C_{IN} = 0.1μF, I_{IN}≤ 4.5A and T_A = 25°C.

Symbol	Description	Test Conditions		Min.	Typ.	Max.	Units
R_{dson}	Switch on resistance	V_{IN} = 5V, I_{OUT} = 1A, T_A = 25°C			30	40	mΩ
I_Q	Input quiescent current	V_{IN} = 5V, I_{OUT} = 0A			78	120	μA
Protection							
V_{IN_OVLO}	OVP trip level	AW33201	V_{IN} rising	6.0	6.2	6.4	V
			Hysteresis		0.11		
		AW33205	V_{IN} rising	6.66	6.80	6.94	
			Hysteresis		0.15		
		AW33209	V_{IN} rising	10.2	10.5	10.8	
			Hysteresis		0.22		
V_{IN_UVLO}	UVLO trip level	AW33201/ AW33209	V_{IN} rising		2.3	2.5	V
			Hysteresis		0.14		
		AW33205	V_{IN} rising		2.2	2.4	
			Hysteresis		0.08		
T_{SDN}	Shutdown temperature	AW33201/AW33209			140		°C
		AW33205			150		
T_{SDN_HYS}	Shutdown temperature hysteresis				20		°C
Timing Characteristics (Figure 5)							
t_{DEB}	Debounce time	From V_{IN} > V_{IN_UVLO} to 10% V_{OUT}			15		ms
t_{ON}	Switch turn-on time	R_L = 100Ω, C_L = 22μF, V_{OUT} from 10% V_{IN} to 90% V_{IN}			2		ms
t_{OFF}	Switch turn-off time	R_L = 100Ω, C_L = 0μF, V_{IN} > V_{IN_OVLO} to V_{OUT} stop rising, V_{IN} rise at 10V/μs			100		ns

TIMING DIAGRAM

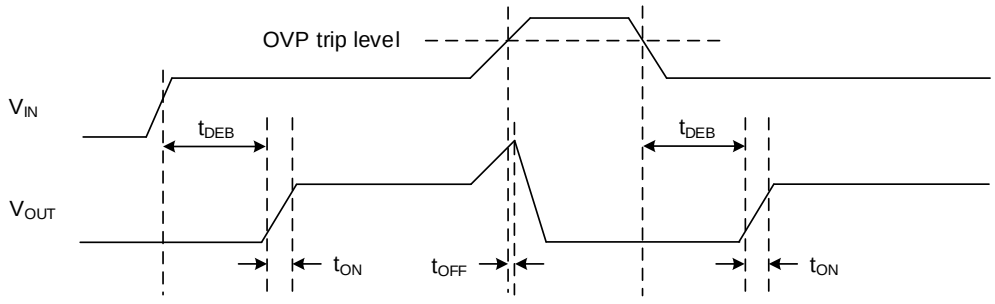


Figure 5 Timing diagram

TYPICAL CHARACTERISTICS

Table 1 Table of Figures

V_{IN} = 5V, C_{IN} = 0.1μF, C_{OUT} = 1μF, and T_A = 25°C unless otherwise specified.

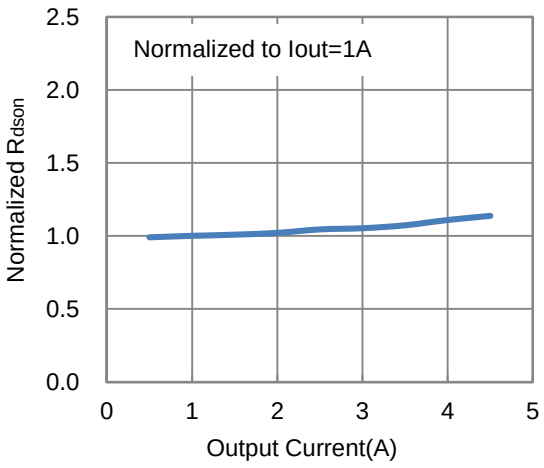


Figure 6 Normalized R_{dson} vs. Output Current

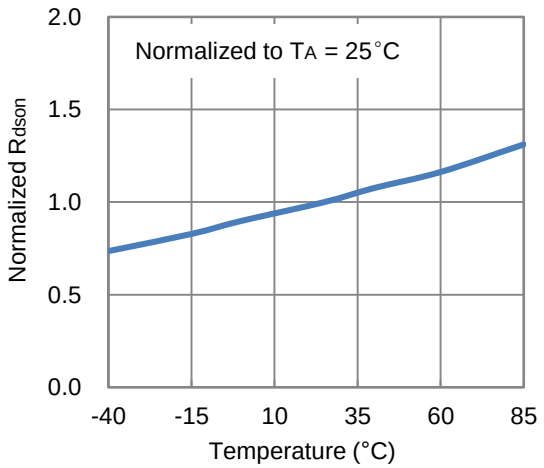


Figure 7 Normalized R_{dson} vs. Temp. (I_{OUT} = 1A)

TYPICAL CHARACTERISTICS (CONTINUED)

V_{IN} = 5V, C_{IN} = 0.1μF, C_{OUT} = 1μF, and T_A = 25°C unless otherwise specified.

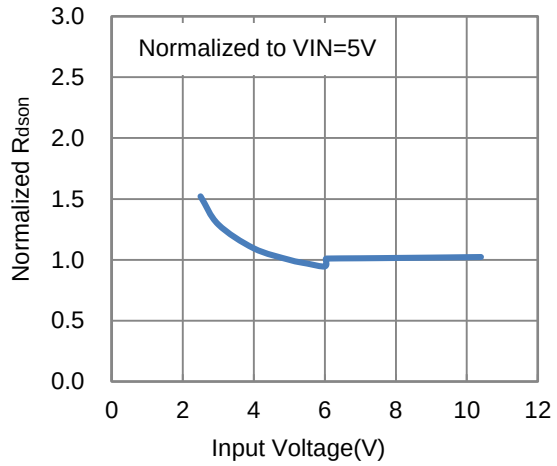


Figure 8 Normalized R_{dson} vs. Input Voltage (I_{OUT} = 1A)

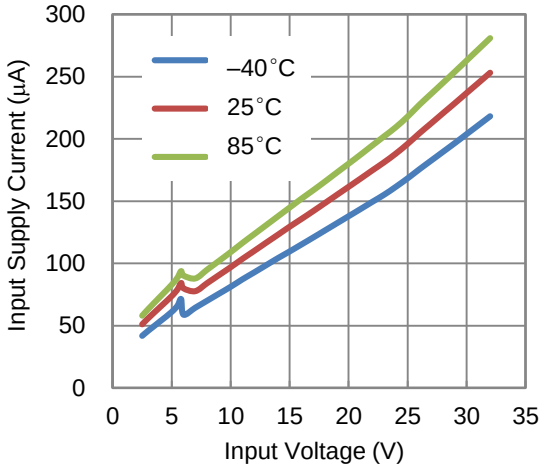


Figure 9 Input Supply Current vs. Supply Voltage

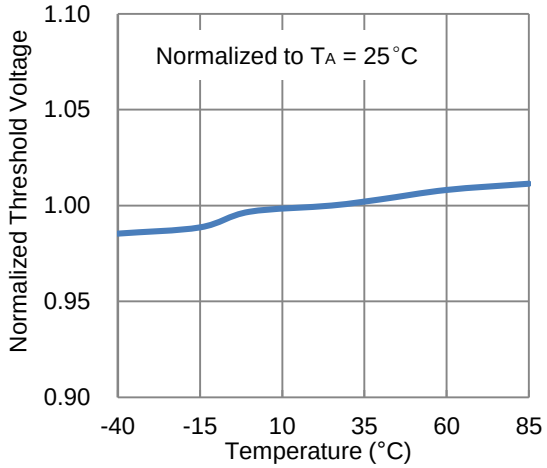


Figure 10 Normalized OVP Threshold vs. Temp.

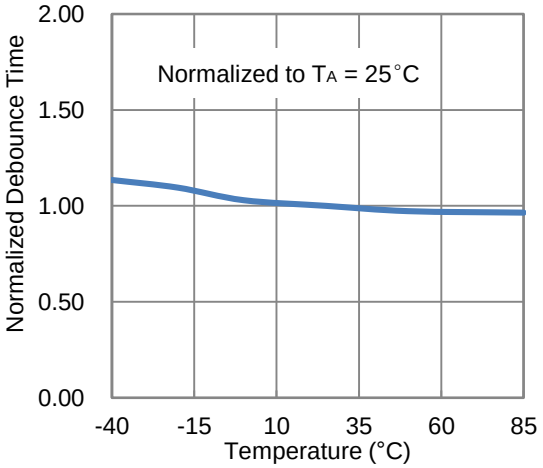


Figure 11 Normalized Debounce Time vs. Temp.

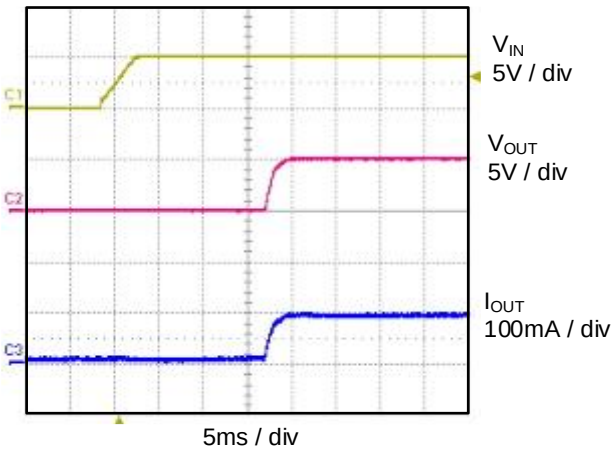


Figure 12 Power-up (C_{OUT} = 1μF, 100mA load)

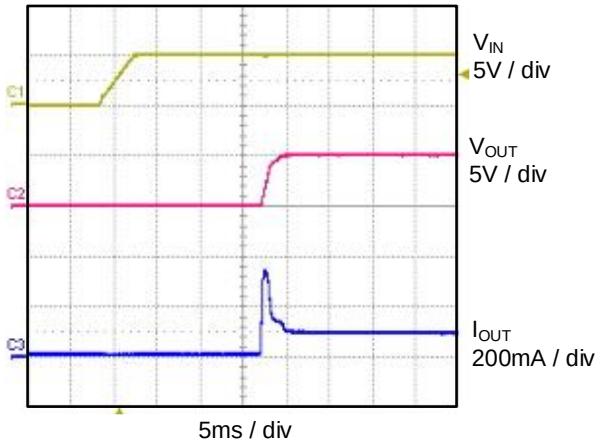


Figure 13 Power-up (C_{OUT} = 100μF, 100mA load)

TYPICAL CHARACTERISTICS (CONTINUED)

V_{IN} = 5V, C_{IN} = 0.1μF, C_{OUT} = 1μF, and T_A = 25°C unless otherwise specified.

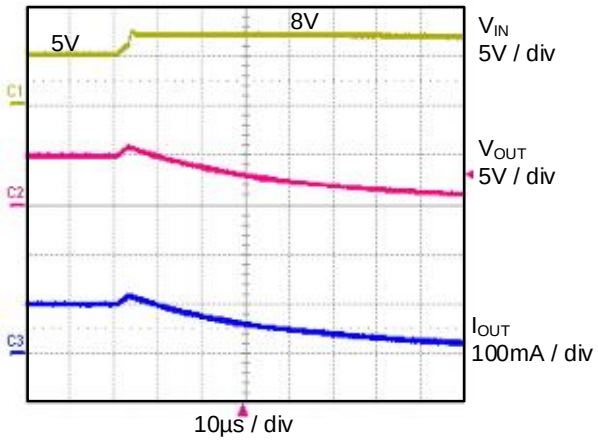


Figure 14 OVP Response (AW33201)

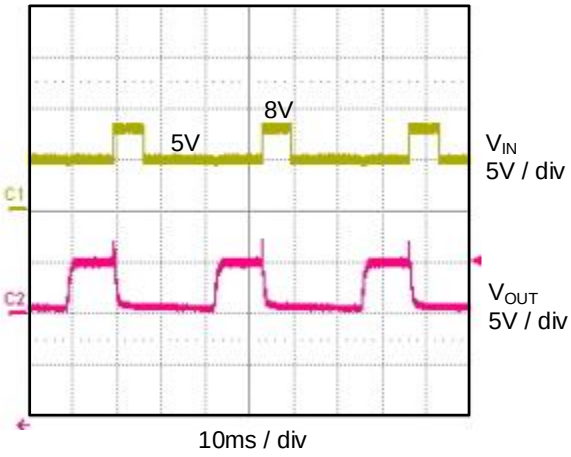


Figure 15 Recovery from OVP(AW33201)

FUNCTIONAL DESCRIPTION

Device Operation

If the input voltage is between UVLO and OVP threshold, the internal charge pump begins to work after debounce time, the gate of the nFET switch will be slowly charged high till the switch is fully on. If the input voltage exceeds the OVP trip level, the switch will be turned off in about 100ns. If input voltage falls below UVLO threshold, or over-temperature happens, the switch will also be turned off.

Over-Voltage Protection

If the input voltage exceeds the OVP rising trip level, the switch will be turned off in about 100ns. The switch will remain off until V_{IN} falls below the OVP falling trip level.

USB On-The-Go (OTG) Operation

If V_{IN} = 0V and OUT is supplied by OTG voltage, the body diode of the load switch conducts current from OUT to IN and the voltage drop from OUT to IN is approximately 0.7V. When $V_{IN} > V_{IN\_UVLO}$, internal charge pump begins to open the load switch after debounce time. After switch is fully on, current is supplied through switch channel and the voltage drop from OUT to IN is minimum.

PCB LAYOUT CONSIDERATION

To make fully use of the performance of AW332XX, the guidelines below should be followed.

1. All the peripherals should be placed as close to the device as possible. Place the input capacitor C_{IN} on the top layer (same layer as the AW332XX) and close to IN pin, and place the output capacitor C_{OUT} on the top layer (same layer as the AW332XX) and close to OUT pin.

2. IN pin routing passes through the external TVS firstly, and then connect AW332XX.

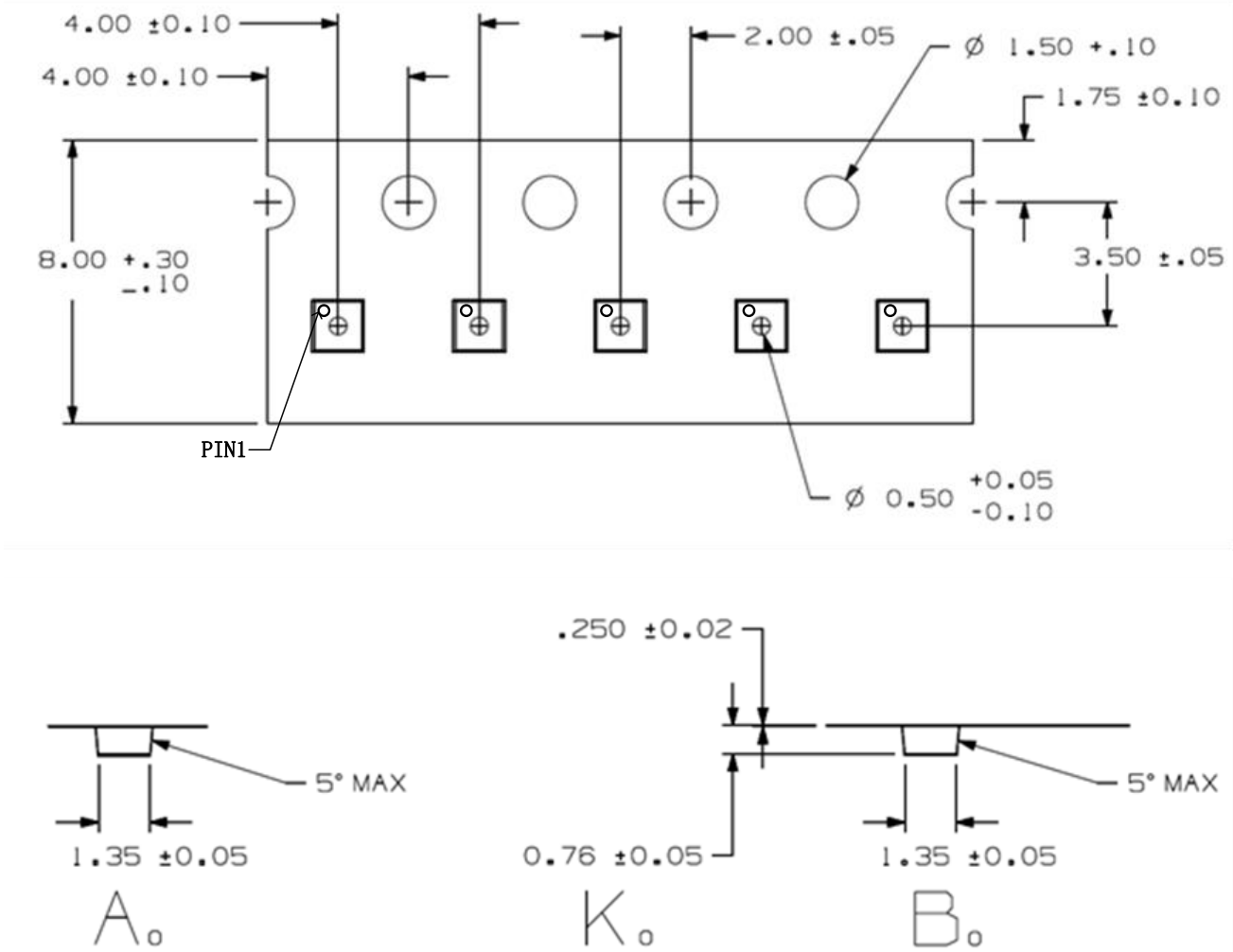
3. Red bold paths on figure 4 and 5 are power lines that will flow large current, please route them on PCB as straight, wide and short as possible.

4. The power trace from USB connector to AW332XX may suffer from ESD event, keep other traces away from it to minimize possible EMI and ESD coupling.

5. Use rounded corners on the power trace from USB connector to AW332XX to decrease EMI coupling.

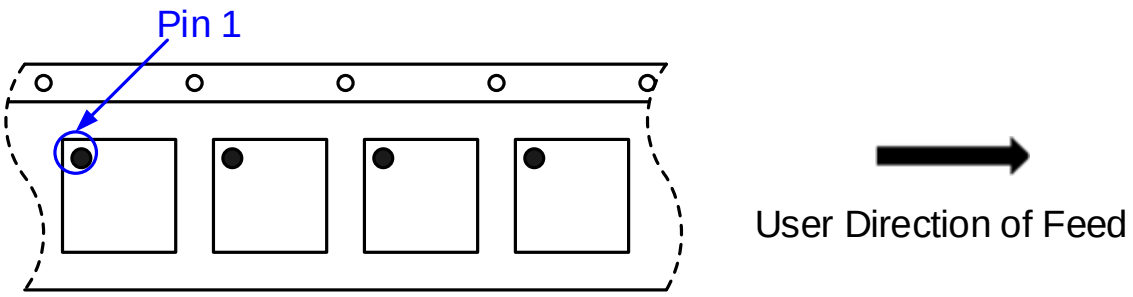
TAPE AND REEL INFORMATION

CARRIER TAPE

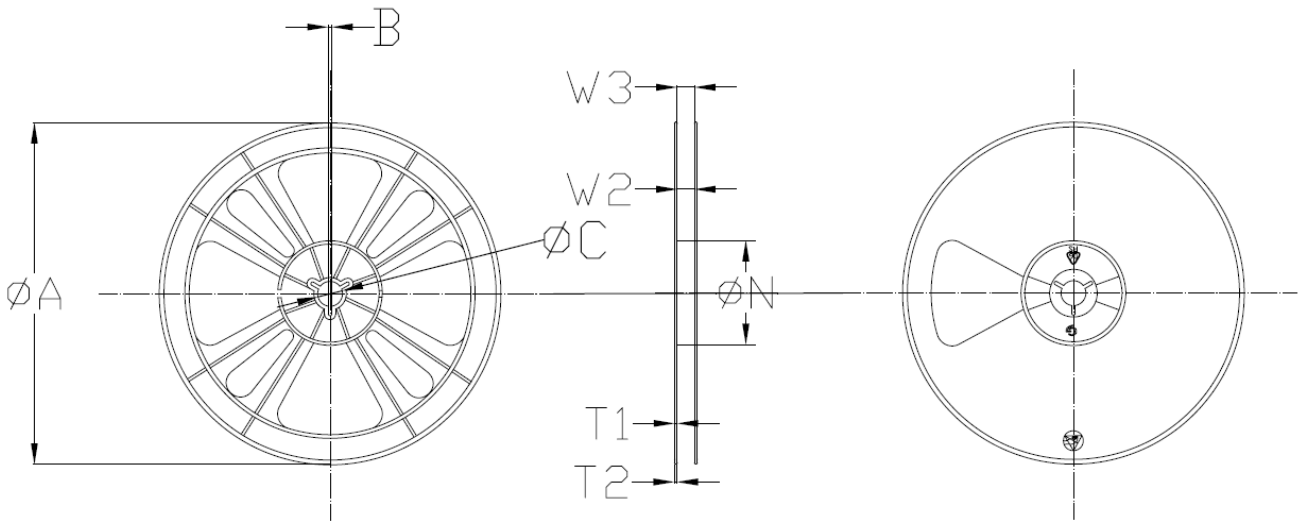


Unit: mm

Pin 1 direction



REEL



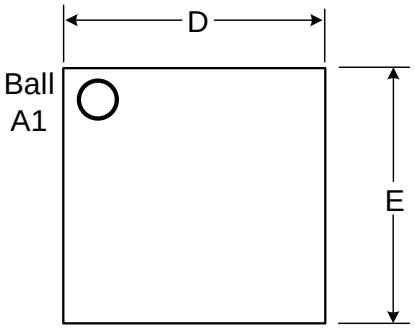
Item	Value&Tolerance
A	179±1.0
B	2.0±0.1
C	13.5±0.2
N	54.8±0.2
W2	9.0±0.2
W3	9.2+1.0
T1	1.2±0.2
T2	1.5±0.2

NOTE:

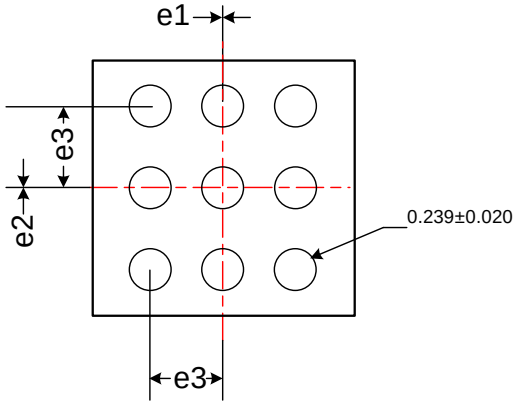
1. Unit: mm;
2. Surface resistivity: 10^5 to 10^{11} ohms/sq;
3. Restriction criterion of hazardous substance for packing material follow GP-M001.

PACKAGE DESCRIPTION

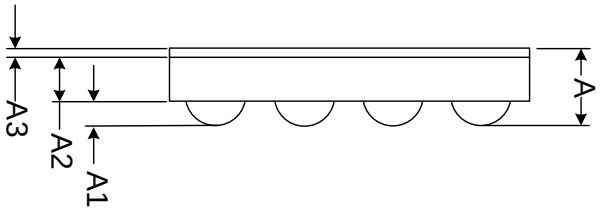
TOP VIEW



BOTTOM VIEW



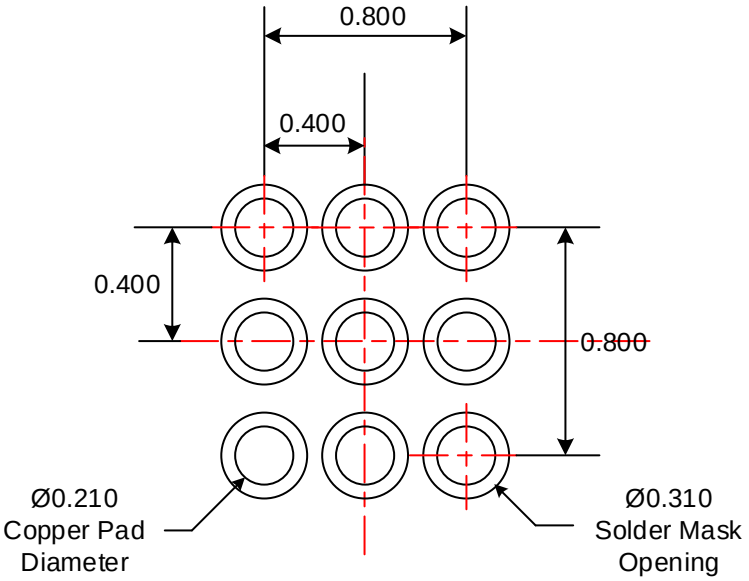
SIDE VIEW



Symbol	NOM	Tolerance
A	0.597	±0.055
A1	0.177	±0.020
A2	0.380	±0.025
A3	0.040	±0.010
D	1.245	±0.025
E	1.245	±0.025
e1	0	NA
e2	0	NA
e3	0.400	NA

Unit: mm

LAND PATTERN DATA



Unit: mm

REFLOW

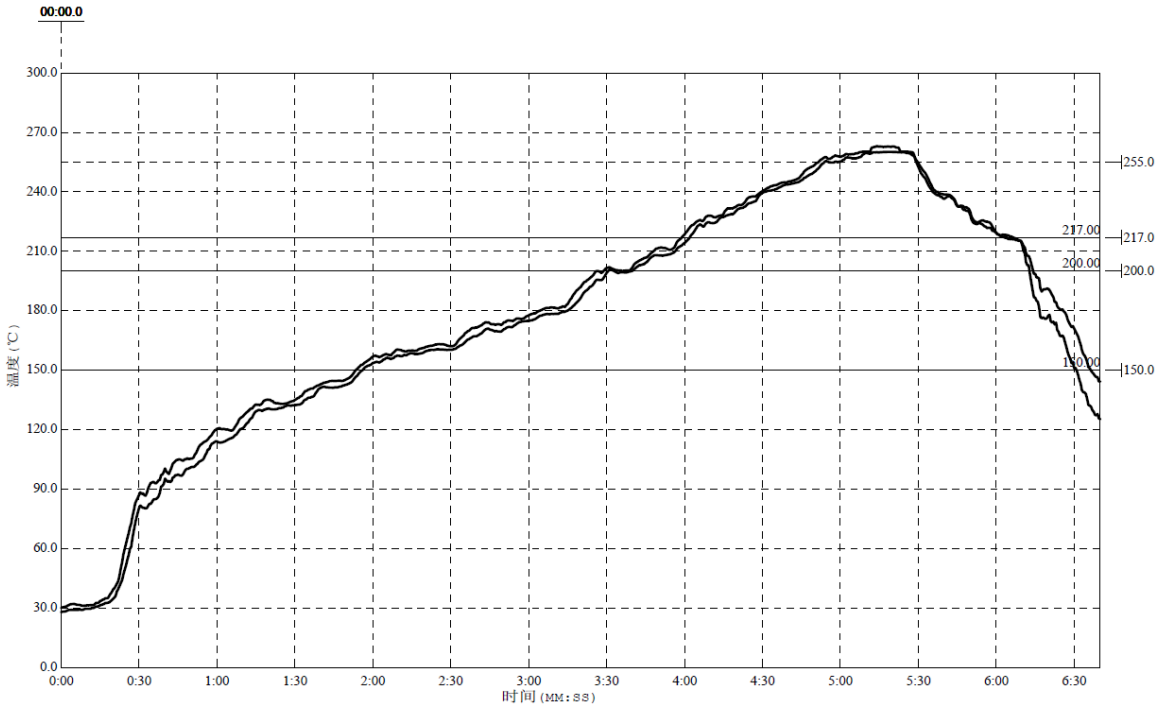


Figure 16 Package Reflow Oven Thermal Profile

Reflow Note	Spec
Average ramp-up rate (217°C to Peak)	Max. 3°C /sec
Time of Preheat temp.(from 150°C to 200°C)	60-120sec
Time to be maintained above 217°C	60-150sec
Peak Temperature	>260°C
Time within 5°C of actual peak temp	20-40 sec
Ramp-down rate	Max. 6°C /sec
Time from 25°C to peak temp	Max. 8min

NOTE 1: All data are compared with the package-top temperature, measured on the package surface;

NOTE 2: AW332XX adopted the Pb-Free assembly.

REVISION HISTORY

Vision	Date	Change Record
V0.9	January 2017	Datasheet V0.9 Released
V1.0	March 2017	Added Typical Characteristics
V1.1	April 2017	1. Added PCB layout consideration. 2. Added ROHS and MSL statements. 3. Added Reflow Information.
V1.2	June 2017	Added AW33205 part number
V1.3	January 2018	Added Land Pattern Data

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